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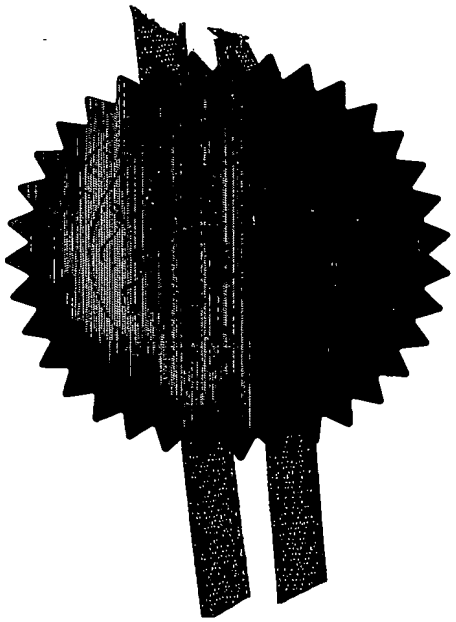

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1. Your reference — sel.2917.uk.kv.d

2. Patent application number *(The Patent Office will fill in this part)* — 11 SEP 2003 — 0321287.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   Safeglass (Europe) Limited
   Whitworth Building
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   G75 0QD

   Patents ADP number *(if you know it)* 08719010001

   If the applicant is a corporate body, give the country/state of its incorporation — UK

4. Title of the invention — Glass like material with improved safety characteristics

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   Kennedys Patent Agency Limited
   Floor 5, Queens House
   29 St Vincent Place
   Glasgow
   G1 2DT

   Patents ADP number *(if you know it)* 0805 824 0002

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature KENNEDYS Date 11 September 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Karen Veitch Tel: 0141 226 6826

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Glass like material with improved safety characteristics.

The present invention relates to a glass-like material which has improved safety characteristics compared to ordinary glass.

In the present Application references to a "glass-like" material refer to a material having the following characteristics; clarity, brittleness, low strain to failure and rigidity.

Ordinary glass is used in a variety of everyday applications. For example it is known in the art to use glass as a protective covering over fire and other types of emergency alarms, emergency door releases, emergency stop buttons on public transport, fire extinguishers, fire axes and the like. As glass is transparent persons can quickly and easily identify the presence of the alarm or apparatus in the retaining box. If required, the glass can be broken in order to access the alarm or device.

However an inherent problem lies in the manner in which the glass can be broken. Often a subsidiary device such

as a hammer is supplied with, or near to, the alarm or apparatus, and can be used to break the glass. However, in the event that this device is missing or cannot be located in an emergency situation it will be necessary for the person who wishes to access the apparatus or alarm to break the glass by some other means. In the event of an emergency situation the person may use, for example, a hand or elbow for this purpose, and may, as a result, sustain injuries from breaking the glass. Breakage of glass results in the production of sharp glass fragments and splinters, which can cause injury to the user or other persons in the proximity of the alarm or apparatus. In addition the potential risk of injury from breaking the glass may cause hesitation on the part of the person who wishes to access the alarm or apparatus, having dangerous consequences.

The glass may also be broken by malicious or accidental damage. Whilst the glass fragments can be removed and the retaining glass replaced, there is an interim risk of injury to persons coming into contact with the broken fragments.

Considerable research has been conducted to find materials which can be used in Applications similar to glass but which minimise the risk of damage to persons in the instance of the material being broken either intentionally or accidentally. Safety glass i.e. toughened glass, materials are well known in the art and have numerous applications and uses. Most have enhanced safety by virtue of being reinforced in strength, such that they have a higher stress to failure than glass; in other words a greater force is needed to shatter or break them than would be required with ordinary glass. Uses

vary from windows and doors on automobiles and public transport, to domestic uses such as shower enclosures and room partitions. Whilst in many instances these have greatly increased safety, they are of limited use in Applications where it is actually desirable for the glass to be broken, i.e. when used on retaining boxes of emergency apparatus and alarms, because of their enhanced strength and resistance to force.

For example the polymeric materials Perspex™ and Plexiglas™, are transparent like glass, and do not pose the same risk of injury when broken. However, these materials can be harder to break than glass and can still produce sharp fragments when broken.

It is therefore an object of the present invention to provide a material which resembles glass, but which has improved safety characteristics when compared to ordinary glass.

According to a first aspect of the present invention there is provided a material which shatters, when broken, into fragments which do not cut, puncture or otherwise damage human skin or tissue, wherein the material is comprised of an amorphous thermoplastic polymer and one or more low molecular weight resins.

Preferably the material is comprised of a simple mixture of amorphous thermoplastic polymer and one or more low molecular weight resins.

Preferably the amorphous thermoplastic polymer is chosen from the group consisting of polystyrene (PS), polymethyl methacrylate (PMAA), styrene-acrylonitrile copolymer

(SAN), linear polyesters and co-polyesters and polycarbonate (PC).

The one or more low molecular weight resins chosen will be completely compatible with the chosen polymer. For example in the case of polystyrene the low molecular weight resin is typically C9 aromatic hydrocarbon resin.

Preferably the material has a tensile stress limit of between 11 and 60 Nmm^{-2}.

Preferably the low molecular weight resin will have a Mn (number average molecular weight) such that it has less than 500 repeating units, and preferably less than 50 repeating units.

The material may be manufactured in sheet form.

According to a second aspect of the present invention there is provided a polymeric blend comprising a polymer selected from the group consisting of: polystyrene, (PS), polymethyl methacrylate (PMAA), styrene-acrylonitrile copolymer (SAN), linear polyesters and co-polyesters and polycarbonate (PC) and one or more low molecular weight resins.

The one or more low molecular weight resins chosen will be completely compatible with the chosen polymer. For example in the case of polystyrene the low molecular weight resin is typically C9 aromatic hydrocarbon resin.

Preferably the one or more low molecular weight resins have a Mn (number average molecular weight) such that it

has less than 500 repeating units, and preferably less than 50 repeating units.

Preferably the one or more low molecular weight resins are hydrocarbon resins.

Preferably the one or more low molecular weight resins are aromatic hydrocarbon resins.

The polymeric blend may be manufactured in sheet form.

According to a third aspect of the present invention there is provided a material which shatters, when broken, into fragments which do not cut, puncture or damage human skin or tissue, the material being comprised of polystyrene and one or more low molecular weight resins.

Preferably the material is comprised of a simple mixture of polystyrene and one or more low molecular weight resins.

Preferably the one or more low molecular weight resins are hydrocarbon resins.

Preferably the one or more low molecular weight resins are aromatic hydrocarbon resins.

Most preferably the one or more low molecular weight hydrocarbon resins are C9 aromatic hydrocarbon resins.

Preferably the one or more low molecular weight resins are, or are derived from, alpha methyl styrene.

Preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of; Norsolene™, Kristalex™, Plastolyn™ Endex™, Piccotex™, Piccolastic™, Sukorez™ or Arkon™.

Most preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of; Norsolene W90™, Norsolene W100™, Norsolene W110™, Kristalex F85 ™, Kristalex F100 ™, Kristalex F115 ™, Plastolyn 240 ™, Plastolyn 290 ™, Endex 155 ™, Piccolastic D125 ™, Sukorez 100 ™, Sukorez 120 ™, Arkon P100 ™, Arkon P125 ™, Arkon P140 ™, Piccotex 75 ™, Piccotex 100 ™ or Piccotex 120 ™.

Preferably the one or more low molecular weight resins will have a Mn (number average molecular weight) such that it has less than 500 repeating units, and preferably less than 50 repeating units.

Preferably the material has a tensile stress limit between 11 and 60 Nmm^{-2}.

Optionally the material may also include UV inhibitors, antioxidants, flow modifiers, fire retarding agents, colour pigments and brighteners as known in the art.

The material may be manufactured in sheet form.

According to a fourth aspect of the present invention there is provided a method of manufacturing a material which shatters, when broken, into which do not cut, puncture or damage human skin or tissue, the method comprising the step of mixing an amorphous thermoplastic polymer and one or more low molecular weight resins.

Preferably the amorphous thermoplastic polymer is chosen from the group consisting of polystyrene (PS), polymethyl methacrylate (PMAA), styrene-acrylonitrile copolymer (SAN), linear polyesters and co-polyesters and polycarbonate (PC).

Preferably the one or more low molecular weight resins are completely compatible with the chosen polymer. For example in the case of polystyrene preferably the chosen low molecular weight resin is C9 aromatic hydrocarbon resin.

Preferably the one or more low molecular weight resins are hydrocarbon resins.

Preferably the one or more low molecular weight resins are aromatic hydrocarbon resins.

Preferably the low molecular weight resin will have a Mn (number average molecular weight) such that it has less than 500 repeating units, and preferably less than 50 repeating units.

Preferably as the polystyrene is mixed with the one or more low molecular weight hydrocarbon resins, the glass transition temperature (T_g) of the material is elevated. Typically the Tg is elevated to 5-10 degress C higher than the base polymer.

According to a fifth aspect of the present invention there is provided a method of manufacturing a material which shatters, when broken, into fragments which do not cut, puncture or damage human skin or tissue, the method

comprising the step of mixing polystyrene and one or more low molecular weight hydrocarbon resins.

Preferably the one or more low molecular weight resins are hydrocarbon resins.

Preferably the one or more low molecular weight resins are aromatic hydrocarbon resins.

Most preferably the one or more low molecular weight hydrocarbon resins are C9 aromatic hydrocarbon resins.

Preferably the one or more low molecular weight resins are, or are derived from, alpha methyl styrene.

Preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of; Norsolene™, Kristalex™, Plastolyn™ Endex™, Piccotex™, Piccolastic™, Sukorez™ or Arkon™.

Most preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of; Norsolene W90™, Norsolene W100™, Norsolene W110™, Kristalex F85 ™, Kristalex F100 ™, Kristalex F115 ™, Plastolyn 240 ™, Plastolyn 290 ™, Endex 155 ™, Piccolastic D125 ™, Sukorez 100 ™, Sukorez 120 ™, Arkon P100 ™, Arkon P125 ™, Arkon P140 ™, Piccotex 75 ™, Piccotex 100 ™ or Piccotex 120 ™.

Preferably the low molecular weight resin will have a Mn (number average molecular weight) such that it has less than 500 repeating units, and preferably less than 50 repeating units.

The method may comprise the optional step of adding an additive selected from the group consisting of UV inhibitors, antioxidants, flow modifiers, fire retarding agents, colour pigments and brighteners as known in the art.

Preferably as the polystyrene is mixed with the one or more low molecular weight hydrocarbon resins, the glass transition temperature (T_g) of the material is elevated. Typically the Tg is elevated to 5-10 degress C higher than the base polymer.

The material herein described can be used as a substitute for ordinary glass. The material is glass-like in character having clarity, brittleness, low strain to failure and rigidity. The material has a variety of uses including application as enclosures and boxes to house emergency equipment e.g. keys, first aid boxes, fire extinguisher, window hammers, emergency stop buttons, emergency kick out panels and alarms, as well as use in access panels, windows and doors. It should be recognised that the abovedescribed uses are by way of example only and are not intended to limit the manner in which the material is used. The material can be manufactured in sheet form, by extrusion, and moulded into any shape by injection moulding or other standard melt processes.

Table 1 shows the stress-strain behaviour of the material in comparison to other polystyrene materials. Figure 1 shows this information in the form of a graph.

Table : Comparison of Properties of Safaglass™ to Polystyrenes.

	Modulus	Yield	Yield	Stress	Strain	Vicat

Polymer Type:	/ GPa	stress / MPa	strain / %	at break / MPa	at break / %	softening temperature
Polystyrene (i.e. "crystal" or GPPS)	3.0 - 3.2	Brittle - no yield		4- - 75	2	82 - 98
Toughened polystyrene (e.g. HIPS)	1.6 - 2.4	18 - 38	1.8	< yield	15 - >50	76 -95
Safeglass™	3.1 - 3.4	Brittle - no yield		8 - 40	1 - 2	95 - 104

N.B. Safeglass™ materials are slighly more rigid and certainly more brittle than conventional "crystal"polystyrene. Modified polystyrenes are invariably less rigid and tougher materials as a result of blending with a rubbery (low T_g) additive. This also results in a lowering of the Glass Transition Temperature (T_g) as witnessed by the reduction in the Vicat Softening Temperature. The reverse is true of Safeglass™ materials which show no such decrease in T_g, indeed it can be higher than c.

The material is fundamentally a blend of a rigid and normally brittle amorphous thermoplastic with a glass transition temperature Tg at least 5° C above ambient and one or more compatible low molecular weight resins.

An example embodiment will now be described by way of example only.

A rigid and normally brittle amorphous thermoplastic polymer is blended with one or more low molecular weight resins which have a Mn (number average molecular weight) such that the resin has less than 500 repeating units, preferably less than 50 repeating units. The one or more low molecular weight resins have a weight average molecular weight of 6050 or below.

The material is manufactured by mixing or blending a clear polymer with one or more low molecular weight hydrocarbon resins. The polymer is an amorphous thermoplastic and can be chosen from the group of polystyrene, (PS), polymethyl methacrylate (PMAA), styrene-acrylonitrile copolymer (SAN), linear polyesters and co-polyesters and polycarbonate (PC). It is important that the low molecular weight resin is completely compatible with the chosen polymer. For example in the case of polystyrene it is C9 aromatic hydrocarbon resin.

In the herein described embodiment polystyrene is used.

The one or more low molecular weight resins which are mixed with the polystyrene are aromatic hydrocarbon resins and typically C9 aromatic hydrocarbon resins. The one or more resins are typically alpha methyl styrene or vinyl toluene or derivatives thereof. These are selected from the following group: Norsolene W90™, Norsolene W100™, Norsolene W110™, Kristalex F85 ™, Kristalex F100 ™, Kristalex F115 ™, Plastolyn 240 ™, Plastolyn 290 ™, Endex 155 ™, Piccolastic D125 ™, Sukorez 100 ™, Sukorez 120 ™, Arkon P100 ™, Arkon P125 ™, Arkon P140 ™, Piccotex 75 ™, Piccotex 100 ™ or Piccotex 120 ™.

It has been discovered that by blending polystyrene with one or more of the abovementioned low molecular weight hydrocarbon resins, a hard, rigid material is formed which has the appearance and feel of glass, but which is extremely brittle and has low strain to failure. The material also has the inherent advantage that when broken, unlike glass, the material breaks into fragments which are not sharp and do not injure skin or tissue. The material is, by design, manufactured to break between 11

and 60 Nmm^{-2}. Therefore the material, when provided as a substitute to glass, for example in retaining boxes for emergency devices and alarms, can easily be broken by a human hand, fist, elbow, foot or the like and advantageously shatters into fragments or pieces which are not sharp and are not capable of cutting or puncturing human skin. Due to the inherent advantages of the material it is envisaged that it may have a variety of other uses, for example it may have application in novelty toys, such as stress relief toys, or have uses in "stunt" apparatus in, for example, theatres, shows or on film sets.

The material is manufactured by conventional melt compounding techniques. As the polystyrene is mixed with the one or more low molecular weight hydrocarbon resins, the glass transition temperature (T_g) of the material is elevated as the low molecular weight resin does not have a plasticising effect, the opposite effect is seen as the glass transition temperature of the material is elevated.

The material is generally transparent or clear, however dyes may be added to change the appearance of the material.

Low molecular weight in resins is a function of the length of the chains in the resin. In this case the hydrocarbon resins have a very low molecular weight, too low in fact for the resins to be of any use on their own, and are difficult to mould. By mixing low molecular weight hydrocarbon resin with polystyrene, the stress limit of the polystyrene is reduced giving the material the characteristics described in the present Application. Preferably the low molecular weight resin will have a Mn

(number average molecular weight) such that it has less than 500 repeating units, and preferably less than 50 repeating units.

The following is an example of the material of the present invention.

Example 1

In order to achieve a material with a stress limit of 24 Mpa, a 50% mix of polymer and 50% resin is used, which acheieves this stress limit. Typically the polymer could be crystal polystyrene such as Polystyrol™ 143E, and resin Plastolyn™ 240.

Example 2

In order to achieve a material with a stress limit of 34 Mpa, a 60% mix of polymer and 40% resin is used, which acheieves this stress limit. Typically the polymer could be crystal polystyrene such as Polystyrol™ 143E, and resin Plastolyn™ 240.

Further modifications and improvements may be added without departing from the scope of the invention herein intended.

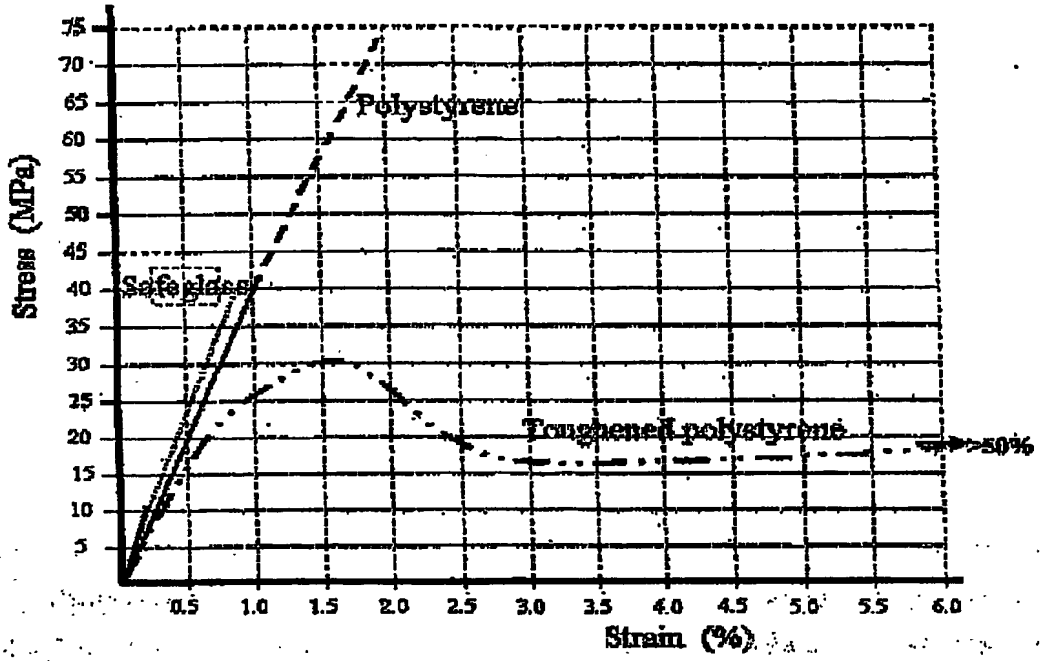
Stress (MPa)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Polystyrene
Safetylase
Toughened polystyrene
>50%
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Strain (%)

FIGURE 1

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